



Standard Specification for Rotary Positive Displacement Pumps, Commercial Ships Use¹

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1. Scope

1.1 This specification defines the requirements applicable to design and construction of rotary positive displacement pumps for shipboard use. The classes of service are shown in Section 4.

1.2 This specification will not include pumps for hydraulic service or cargo unloading applications.

2. Referenced Documents

2.1 ASTM Standards:²

A 27/A 27M Specification for Steel Castings, Carbon, for General Application

A 36/A 36M Specification for Carbon Structural Steel

A 48/A 48M Specification for Gray Iron Castings

A 53/A 53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A 159 Specification for Automotive Gray Iron Castings

A 193/A 193M Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications

A 194/A 194M Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

A 322 Specification for Steel Bars, Alloy, Standard Grades

A 354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

A 395/A 395M Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

A 434 Specification for Steel Bars, Alloy, Hot-Wrought or Cold-Finished, Quenched and Tempered

A 449 Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

A 515/A 515M Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

A 536 Specification for Ductile Iron Castings

A 563 Specification for Carbons and Alloy Steel Nuts

A 564/A 564M Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes

A 574 Specification for Alloy Steel Socket-Head Cap Screws

A 582/A 582M Specification for Free-Machining Stainless Steel Bars

A 743/A 743M Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application

B 150M Specification for Aluminum Bronze, Rod, Bar, and Shapes [Metric]

B 584 Specification for Copper Alloy Sand Castings for General Applications

D 1418 Practice for Rubber and Rubber Latices Nomenclature

D 2000 Classification System for Rubber Products in Automotive Applications

D 3951 Practice for Commercial Packaging

F 104 Classification System for Nonmetallic Gasket Materials

F 912 Specification for Alloy Steel Socket Set Screws

F 1511 Specification for Mechanical Seals for Shipboard Pump Applications

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 *ANSI Standard:*³

B 16.5 Pipe Flanges and Flanged Fittings

2.3 *SAE Standards:*⁴

AS 568A Aerospace Size Standard for O-Rings

J 429 Mechanical and Material Requirements for Externally Threaded Fasteners

2.4 *AMS Standard:*⁴

3215 Acrylonitrile Butadiene (NBR) Rubber Aromatic Fuel Resistant 65-75

2.5 *ABMA Standards:*⁵

9 Load Ratings and Fatigue Life for Ball Bearings

11 Load Ratings and Fatigue Life for Roller Bearings

2.6 *AGMA Standard:*⁶

390.03 Gear Classification, Materials and Measuring Methods for Unassembled Gears

2.7 *API Standard:*⁷

676 Positive Displacement Pumps—Rotary

2.8 *Military Standards:*⁸

MIL-S-901

MIL-STD-167

MIL-STD-740

3. Terminology

3.1 *Definitions:*

3.1.1 *capacity*—the quantity of fluid actually delivered per unit of time at the rated speed, including both the liquid and dissolved or entrained gases, under stated operating conditions. In the absence of any gas or vapor entering or forming within the pump, the capacity is equal to the volume displaced per unit of time, less slip.

3.1.2 *capacity, maximum*—the quantity of fluid delivered that does not exceed the limit determined by the formula in 9.2.

3.1.3 *displacement*—the volume displaced per revolution of the rotor(s). In pumps incorporating two or more rotors operating at different speeds, the displacement is the volume displaced per revolution of the driving rotor. Displacement depends only on the physical dimensions of the pumping elements.

3.1.4 *dry operation*—a brief run during priming or stripping with suction and discharge lines unrestricted and pump chamber wet with liquid but pumping only air or vapor available from the suction.

3.1.5 *efficiency, mechanical*—the ratio of the pump power output (hydraulic horsepower) to the pump power input (brake horsepower) expressed in percent.

3.1.6 *efficiency, volumetric*—the ratio of the pump's capacity to the product of the displacement and the speed expressed in percent.

3.1.7 *fuel, clean*—fuel purified for direct use.

3.1.8 *fuel, dirty*—fuel before purification which may contain water and some solids.

3.1.9 *net positive inlet pressure available (NPIPA)*—the total inlet pressure available from the system at the pump inlet connection at the rated flow, minus the vapor pressure of the liquid at the pumping temperature.

3.1.10 *net positive inlet pressure required (NPIPR)*—the net pressure above the liquid vapor pressure at rated flow and pumping temperature and at the pump inlet connection required to avoid performance impairment due to cavitation.

3.1.11 *pressure, cracking*—sometimes called set pressure, start-to-discharge pressure, or popping pressure—the pressure at which the relief valve just starts to open. This pressure cannot be determined readily if the relief valve is internal to the pump and it bypasses the liquid within the pump.

3.1.12 *pressure, differential*—the difference between discharge pressure and inlet pressure.

3.1.13 *pressure, discharge*—the pressure at the outlet of the pump. Discharge pressure is sometimes called outlet pressure.

3.1.14 *pressure, inlet*—the total pressure at the inlet of the pump. Inlet pressure is sometimes called suction pressure.

3.1.15 *pressure, maximum allowable working*—the maximum continuous pressure for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified temperature. This pressure should not be greater than $\frac{2}{3}$ of the hydrostatic test pressure of the pressure containing parts.

3.1.16 *rated condition*—defined by discharge pressure, inlet pressure, capacity, and viscosity.

3.1.17 *rotary pump*—a positive displacement pump consisting of a casing containing gears, screws, lobes, cams, vanes, shoes, or similar elements actuated by relative rotation between the drive shaft and the casing. There are no inlet and outlet valves. These pumps are characterized by their close running clearances.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁴ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

⁵ Available from American Bearing Manufacturers Association (ABMA), 2025 M Street, NW Suite 800, Washington, DC 20036, <http://www.abma-dc.org/>.

⁶ Available from American Gear Manufacturer's Association (AGMA), 500 Montgomery St., Suite 350, Alexandria, VA 22314-1581, <http://www.agma.org>.

⁷ Available from American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005-4070, <http://api-ec.api.org>.

⁸ Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

3.1.18 *slip*—the quantity of fluid that leaks through the internal clearances of a rotary pump per unit of time. Slip depends on the internal clearances, the differential pressure, the characteristics of the fluid handled and in some cases, the speed.

3.1.19 *speed, maximum allowable (in revolutions per minute)*—the highest speed at which the manufacturers’ design will permit continuous operation.

3.1.20 *speed, minimum allowable (in revolutions per minute)*—the lowest speed at which the manufacturers’ design will permit continuous operation.

3.1.21 *speed, rated*—the number of revolutions per minute of the driving rotor required to meet the rated conditions.

3.1.22 *suction lift*—a term used to define a pump’s capability to induce a partial vacuum at the pump inlet.

3.1.23 *temperature, maximum allowable*—the maximum continuous temperature for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified pressure.

4. Classification

4.1 Pumps will be classified as follows:

4.1.1 *Types:*

4.1.1.1 *Type II*—Screws with timing gears.

4.1.1.2 *Type III*—Screws without timing gears.

4.1.1.3 *Type IV*—Impellers with timing gears.

4.1.1.4 *Type V*—External gear (spur, helical, herringbone, lobe).

4.1.1.5 *Type VIII*—Internal gear, internal rotary lobe.

4.1.1.6 *Type X*—Vane (sliding).

4.1.1.7 *Type XI*—Sliding shoe.

4.1.2 *Classes:*

4.1.2.1 *Class A*—Aqueous film forming foam, AFFF.

4.1.2.2 *Class B*—Bromine.

4.1.2.3 *Class CD*—Clean distillate fuel, viscosity 32 to 100 SSU (2 to 21 centistokes) (for example, jet fuel, JP-5, fuel).

4.1.2.4 *Class CH*—Clean heavy fuel, viscosity 100 to 1500 SSU (21 to 325 centistokes) (propulsion fuel).

4.1.2.5 *Class DD*—Dirty distillate fuel, viscosity 32 to 100 SSU (2 to 21 centistokes) (for example, transfer, stripping, purifier feed, leak-off).

4.1.2.6 *Class DH*—Dirty heavy oil, viscosity 32 to 4000 SSU (2 to 863 centistokes) (for example, waste oil, transfer, stripping, purifier feed, drains).

4.1.2.7 *Class G*—Gasoline, aviation gasoline, gasohol.

4.1.2.8 *Class LM*—Lube oil, viscosity 130 to 4000 SSU (27 to 863 centistokes) (for example, propulsion, SSTG, control, L.O. service).

4.1.2.9 *Class LA*—Auxiliary L.O. 130 to 4000 SSU (27 to 863 centistokes) service and L.O. transfer.

4.1.2.10 *Class M*—Miscellaneous.

4.1.2.11 *Class W*—Heavily contaminated seawater, viscosity 32 to 4000 SSU (2 to 863 centistokes) (bilge stripping, oily waste transfer).

5. Ordering Data

5.1 The ordering activity shall provide manufacturers with all of the following information:

5.1.1 Title, number, and date of specification,

5.1.2 Type and classification, see Section 4,

5.1.3 Capacity in gallons per minute or litres per minute at rated discharge pressure,

5.1.4 Discharge pressure in pound-force per square inch gauge (psig) or kilopascal (kPa) gauge.

5.1.5 Airborne noise levels (if different than 7.5),

5.1.6 Viscosity (only if different than Section 4),

5.1.7 Mounting configuration (vertical, horizontal),

5.1.8 Driver type (motor, turbine, engine, attached),

5.1.9 Driver characteristics or specifications, or both,

5.1.10 Relief valve cracking pressure and full-flow bypass pressure,

5.1.11 Packaging and boxing requirements (immediate use, domestic; storage, domestic; overseas),

5.1.12 Quantity of pumps,

5.1.13 Quantity of drawings,

5.1.14 Quantity of technical manuals,

5.1.15 Quantity of test reports,

5.1.16 Performance test, if required,

5.1.17 Certified data required, and

5.1.18 Instruction plates and locations, if required.

6. Materials

6.1 Pump component parts shall be constructed of the materials shown in Table 1.

6.2 Materials other than shown in Table 1 are considered exceptions and are subject to approval by the purchaser before usage.

7. General Requirements

7.1 Pumps shall be designed for a 20-year service life.

7.2 Pumps shall be capable of sustained operation during inclinations up to 45° in any direction.

7.3 The pumps shall be capable of withstanding environmental vibration induced by shipboard machinery and equipment in the frequency range from 4 to 25 Hz.

7.4 The internally excited vibration levels of the pump shall not exceed 0.003-in. (0.00762-mm) displacement peak to peak during rated operation when readings are measured on the pump case near the coupling perpendicular to the pump shaft.

TABLE 1 Materials

Component	Class A, B, CD, G	Class CH, LM, LA	Class DD, DH	Class W	Specification (UNS)
Casings, heads, and covers	ductile iron	ductile iron	ductile iron		ASTM A 395/A 395M or A 536 , Gr. 60-40-18
	ductile iron	ductile iron			ASTM A 536, Br. 80-55-06
Shafts	leaded tin bronze	leaded tin bronze	leaded tin bronze	leaded tin bronze	ASTM A 27/A 27M, Gr. 65-35
	carbon steel	carbon steel	carbon steel		ASTM B 584 (C93700)
	steel	steel			ASTM A 53/A 53M
	carbon steel	carbon steel			ASTM A 434, Gr. 4140, Cl.BC
	stainless steel	stainless steel	stainless steel	stainless steel	AISI 1141
Rotors	alloy steel	alloy steel			ASTM A 582/A 582M (S41600) and ASTM A 564/A 564M Gr. 630 (S17400)
	cast gray iron	cast gray iron	cast gray iron		ASTM A 322
					ASTM A 159, Gr. G 3500 or ASTM A 48/ A 48M, Cl. 35-50 or 25-50
Rotor housings, liners, and disks	ductile iron (80-55-06 only)	ductile iron			ASTM A 536, Gr. 60-40-18, 80-55-06, or 120-90-02
		alloy steel	stainless steel	stainless steel	AISI 4150 RS, H.T.
	leaded tin bronze	leaded tin bronze	leaded tin bronze	leaded tin bronze	ASTM A 582/A 582M (S41600)
	cast gray iron	cast gray iron	cast gray iron		ASTM B 584 (C93700)
	ductile iron	ductile iron	ductile iron		ASTM A 159, Gr. G 3500
Glands	stainless steel	stainless steel	stainless steel	stainless steel	ASTM A 536, Gr. 60-40-18
	leaded tin bronze	leaded tin bronze	leaded tin bronze	leaded tin bronze	ASTM A 564/A 564M, Gr. 630 (S17400)
	tin bronze	tin bronze	tin bronze		ASTM B 584 (C90300)
Bedplates and brackets	stainless steel	stainless steel	stainless steel	stainless steel	ASTM A 743/A 743M, Gr. CF8M (J92900)
	structural steel	structural steel	structural steel	structural steel	ASTM A 36/A 36M
Timing gears	ductile iron	ductile iron			ASTM A 395/A 395M 5, Gr. 60-40-18
	nitrided steel	nitrided steel	nitrided steel	nitrided steel ⁴	ASTM A 515/A 515M
		aluminum bronze			ASTM A 434, Gr. 4140, Cl.BC
			stainless steel	stainless steel	ASTM B 150M (C63000)
					ASTM A 582/A 582M (S41600)

THE FOLLOWING MATERIALS ARE APPLICABLE TO ALL CLASSES

Fasteners (studs, bolts, screws, nuts)	medium carbon alloy steel bolts				ASTM A 193/A 193M, Gr. B 7
	medium carbon alloy steel nuts				ASTM A 194/A 194M, Gr. 7
	austenitic stainless steel (304/316)				ASTM A 193/A 193M, Gr. B8/B8M
	austenitic stainless steel (304/316)				ASTM A 194/A 194M, Gr. 8/8M
	medium carbon steel bolts and studs				ASTM A 449, Gr 1 (equivalent to SAE Gr 5)
	medium carbon steel nuts				ASTM A 563, Gr B (equivalent to SAE Gr 5)
O-rings and other elastomers	high-strength alloy steel bolts and studs				ASTM A 354, Gr. BD (equivalent to SAE Gr 8)
	high-strength alloy steel nuts				ASTM A 563, Gr. DH (equivalent to SAE Gr 8)
	alloy steel socket-head cap screws				ASTM A 574
	alloy steel socket set screws				ASTM F 912
Gaskets	fluorocarbon (viton, fluorel, or equal)				SAE J 429, Gr. 5, 5.1, 8, or 8.1
	plant and animal fiber				ASTM D 1418 Class: FKM, AS 568A, ASTM D 2000 Type and Class: HK
Vaness and shoes	fluorocarbon				ASTM F 104, I.D. No. P 3313B
	nitrile (Buna-N or equal)				ASTM D 2000 Type and Class: HK, ASTM D 1418 Class: FKM
	leaded tin bronze				AMS 3215
	thermoset plastic				ASTM B 584 (C93700)
					None

⁴Outside of pumpage when separately lubricated.